

Table 1 - Nominal Failure Rates

Type of Failure	Nominal Failure Rate
Cryogenic Storage Tanks (General)	Failures per year of operation
Rupture of Storage Tank Outlet/Withdrawal Line	3E-5 (Failure Rate Criterion)
Single Containment Atmospheric Storage Tanks	Failures per year of operation
Catastrophic Failure, Release to Atmosphere	5E-6 per tank
Catastrophic Failure of Tank Roof	1E-4 per tank
Release from a hole in inner tank with effective diameter of 1m (~3ft)	8E-5 per tank
Release from a hole in inner tank with effective diameter of 0.3m (~1ft)	2E-4 per tank
Release from a hole in inner tank with effective diameter of 0.01m (0.4in)	1E-4 per tank
Double Containment Atmospheric Storage Tanks	Failures per year of operation
Catastrophic Failure, Release to Atmosphere	5E-7 per tank
Catastrophic Failure of Tank Roof	1E-4 per tank
Release from a hole in inner tank with effective diameter of 1m (~3ft)	1E-5 per tank
Release from a hole in inner tank with effective diameter of 0.3m (~1ft)	3E-5 per tank
Release from a hole in inner tank with effective diameter of 0.01m (0.4in)	1E-4 per tank
Full Containment Atmospheric Storage Tanks	Failures per year of operation
Catastrophic Failure, Release to Atmosphere	1E-8 per tank
Catastrophic Failure of Tank Roof	4E-5 per tank
Release from a hole in inner tank with effective diameter of 1m (~3ft)	1E-6 per tank
Release from a hole in inner tank with effective diameter of 0.3m (~1ft)	3E-6 per tank
Release from a hole in inner tank with effective diameter of 0.01m (0.4in)	1E-4 per tank
Process Vessels, Distillation Columns, Heat Exchangers, and Condensers	Failures per year of operation
Catastrophic Failure (Rupture)	5E-6 per vessel
Release from a hole with effective diameter of 0.01m (0.4in)	1E-4 per vessel
Truck Transfer	Failures per year of operation
Rupture of transfer arm	3E-4 per transfer arm
Release from a hole in transfer arm with effective diameter of 10% transfer arm diameter with maximum of 50mm (2-inches)	3E-3 per transfer arm
Rupture of transfer hose	4E-2 per transfer hose
Release from a hole in transfer hose with effective diameter of 10% transfer hose diameter with maximum of 50mm (2-inches)	4E-1 per transfer hose
Ship Transfer	Failures per year of operation
Rupture of transfer arm	2E-5 per transfer arm
Release from a hole in transfer arm with effective diameter of 10% diameter with maximum of 50mm (2-inches)	2E-4 per transfer arm

Type of Failure	FERC Nominal Failure Rate
Piping (General)	Failures per year of operation
Rupture at Valve	9E-6 per valve
Rupture at Expansion Joint	4E-3 per expansion joint
Failure of Gasket	3E-2 per gasket
Piping: $d < 50\text{mm}$ (2-inch)	Failures per year of operation
Catastrophic rupture	1E-6 per meter of piping
Release from hole with effective diameter of 25mm (1-inch)	5E-6 per meter of piping
Piping: 50mm (2-inch) $\leq d < 149\text{mm}$ (6-inch)	Failures per year of operation
Catastrophic rupture	5E-7 per meter of piping
Release from hole with effective diameter of 25mm (1-inch)	2E-6 per meter of piping
Piping: 150mm (6-inch) $\leq d < 299\text{mm}$ (12-inch)	Failures per year of operation
Catastrophic rupture	2E-7 per meter of piping
Release from hole with effective diameter of 1/3 diameter	4E-7 per meter of piping
Release from hole with effective diameter of 25mm (1-inch)	7E-7 per meter of piping
Piping: 300mm (12-inch) $\leq d < 499\text{mm}$ (20-inch)	Failures per year of operation
Catastrophic rupture	7E-8 per meter of piping
Release from hole with effective diameter of 1/3 diameter	2E-7 per meter of piping
Release from hole with effective diameter of 10% diameter, up to 50mm (2-inches)	4E-7 per meter of piping
Release from hole with effective diameter of 25mm (1-inch)	5E-7 per meter of piping
Piping: 500mm (20-inch) $\leq d < 1000\text{mm}$ (40-inch)	Failures per year of operation
Catastrophic rupture	2E-8 per meter of piping
Release from hole with effective diameter of 1/3 diameter	1E-7 per meter of piping
Release from hole with effective diameter of 10% diameter, up to 50mm (2-inches)	2E-7 per meter of piping
Release from hole with effective diameter of 25mm (1-inch)	4E-7 per meter of piping

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